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(72) Inventor: **Ohno, Yukio,**  
**c/o Ohno Engineering Office, GmbH**  
**Yokohama-shi, Kanagawa 234-0055 (JP)**

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(74) Representative: **Köhler, Walter, Dr.-Ing. et al**  
**Louis, & Pöhlau, & Lohrentz**  
**Patentanwälte**  
**P.O. Box 30 55**  
**90014 Nürnberg (DE)**

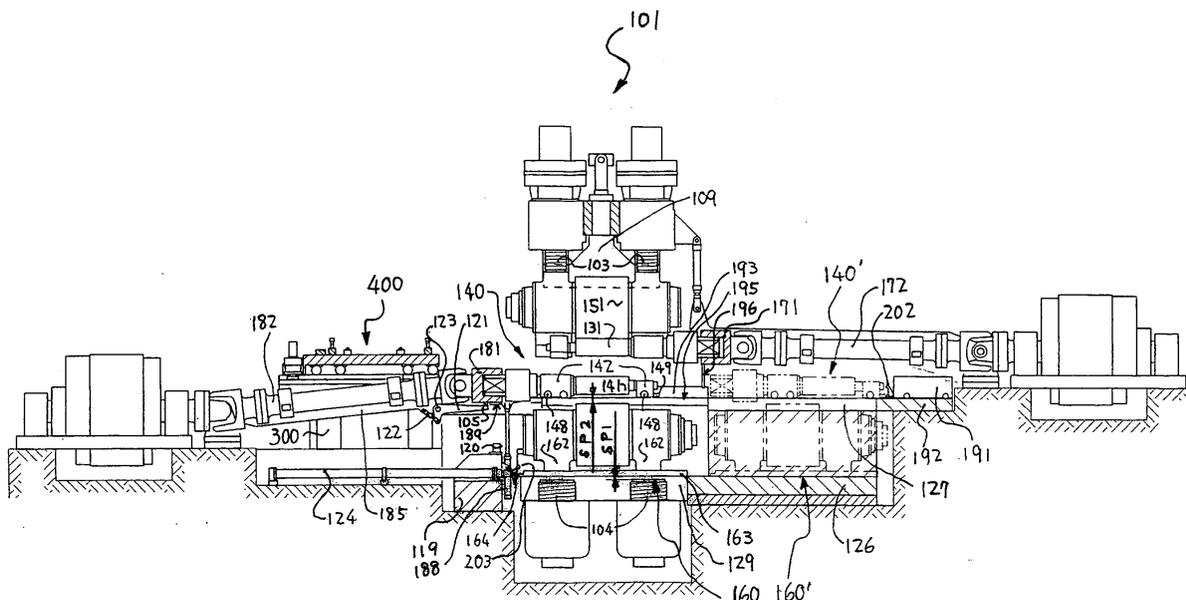
(71) Applicant: **Ohno Engineering Office GmbH**  
**Yokohama-shi, Kanagawa-ken 234-0055 (JP)**

(54) **Roll changing device for a rolling mill**

(57) In a rolling mill (101) with upper and lower drive motors (174 and 184) arranged oppositely to each other with respect to paired upper and lower work rolls (131 and 141), changing of the upper work roll (131) is carried out such that a changing carriage (400) is inserted from

a lower drive motor side to a space in the rolling mill (101) provided by the lower work roll (141) extracted from the rolling mill (101) to an upper drive motor side, the upper work roll (131) being loaded on the changing carriage (400) and then extracted together therewith to the lower drive motor side.

**FIG. 17**



## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of the invention

**[0001]** The present invention relates to a roll changing device in a rolling mill for a metal strip or plate.

#### 2. Description of the Related Art

**[0002]** As shown in Fig. 1, a conventional rolling mill generally denoted by reference numeral 1 comprises a pair of upper and lower work rolls 5 and 6 supported through upper and lower roll chocks 3 and 4, respectively, in a pair of housings 2. The upper work roll 5 is connected at its one or motor-side end to a drive motor 12 via a roll-side universal joint 9, a spindle 10 and a motor-side universal joint 11, the joint 9 being connected to the roll 5 releasably upon roll changing. The lower work roll 6 is connected at its one or motor-side end to a drive motor 18 via a roll-side universal joint 15, a spindle 16 and a motor-side universal joint 17, the joint 15 being connected to the roll 6 releasably upon roll changing.

**[0003]** Arranged on the upper work roll 5 is an upper backup roll 21 which is supported through upper roll chocks 22 in the housings 2 to suppress bending deformation of the work roll 5. Arranged under the lower work roll 6 is a lower backup roll 23 which is supported through lower roll chocks 24 to suppress bending deformation of the work roll 6.

**[0004]** The rolls worn and surface-roughened during a rolling operation will be changed with new ones in a roll changing operation when an extent of roll surface roughness is beyond a predetermined limit. Upon such roll changing, the rolls 5, 6, 21 and 23 are extracted out of the rolling mill 1 in a direction of arrow AR1 into positions shown by two-dot chain lines 5', 6', 21' and 23', respectively, and are changed with new rolls which are then inserted in a direction reverse to the arrow AR1 into positions in the housings 2. Generally, the work and backup roll pairs are changed independently from each other since wear extents and thus changing frequencies of the roll pairs are significantly different from each other.

**[0005]** Torque transmission capability of a universal joint in general is in proportion to its outer diameter raised to the third power and therefore can be increased or decreased by changing the outer diameter. However, the conventional rolling mill 1 shown in Fig. 1 has the roll-side universal joints 9 and 15 vertically aligned to each other, leading to failure of their outer diameter  $d_2'$  being increased greater than a diameter  $d$  of the work rolls 5 and 6. Because of such drawback in the universal joints, the conventional rolling mill cannot respond to a recent technical requirement on greater rolling torque without increasing diameter of work rolls (for example, greater draft or strain rolling at lower temperature is required for new material so-called "Super-Metal" which

was unveiled in a fourth super-metal symposium held in Japan on December 18 and 19, 2001 under the auspices of The Japan Research and Development Center for Metals and R & B Institute of Metals and Composites for Future Industries).

**[0006]** In order to respond to such recent technical requirement, the inventor of the present invention proposed in JP2002-301508A a rolling mill with a drive mechanism capable of transmitting greater torque without increasing work roll diameter a gist of which will be described with reference to Fig. 2.

**[0007]** As shown in Fig. 2, a rolling mill generally denoted by reference numeral 1 comprises a pair of upper and lower work rolls 5 and 6 supported through upper and lower roll chocks 3 and 4, respectively, in a pair of housings 2. The upper work roll 5 is connected at its one or motor-side end to an upper drive motor 12 via an adapter 8 shrinkage-fitted over the motor-side end of the upper work roll, a roll-side universal joint 9, a spindle 10 and a motor-side universal joint 11, the joint 9 being connected to the adapter 8 on the work roll 5 releasably upon roll changing.

**[0008]** The lower work roll 6 is connected at its one or motor-side end to a lower drive motor 18 via an adapter 14 shrinkage-fitted over the motor-side end of the lower work roll, a roll-side universal joint 15, a spindle 16 and a motor-side universal joint 17, the joint 15 being connected to the adapter 14 on the work roll 6 releasably upon roll changing.

**[0009]** The upper and lower drive motors 12 and 18 for the upper and lower work rolls 5 and 6, respectively, are arranged oppositely to each other with respect to the work rolls 5 and 6; in other words, the motor-sides of the work rolls 5 and 6 are opposite to each other with respect to the work rolls 5 and 6.

**[0010]** Arranged on the upper work roll 5 is an upper backup roll 21 which is supported through upper roll chocks 22 in the housings 2 to suppress bending deformation of the work roll 5. Arranged under the lower work roll 6 is a lower backup roll 23 which is supported through lower roll chocks 24 to suppress bending deformation of the work roll 6.

**[0011]** With the thus constructed rolling mill, the roll-side universal joints 9 and 15 are not vertically aligned with each other unlike the conventional rolling mill shown in Fig. 1, so that their outer diameter  $d_2'$  may be made increased independently from and greater than a diameter  $d$  of the work rolls. More specifically, suppose that the work rolls in Figs. 1 and 2 have the same diameter  $d$ ; then, the diameter  $d$  of the work rolls in Figs. 1 and 2 and the diameters  $d_2'$  and  $d_2$  of the roll-side universal joints in Figs. 1 and 2, respectively, may have the following relationship:

$$d_2' < d < d_2$$

Because of this relationship together with the above-

mentioned fact that torque transmission capability of a universal joint is in proportion to its outer diameter raised to the third power and can be increased or decreased by changing the outer diameter, the drive mechanism of Fig. 2 may transmit greater torque than that of Fig. 1.

**[0012]** However, in Fig. 2, the drive motors 12 and 18 are arranged opposite to each other with respect to the work rolls 5 and 6 and thus, upon roll changing, the upper work and backup rolls 5 and 21 must be extracted out of the rolling mill as a unit in a direction of arrow AR2 into positions shown by two-dot chain lines 5' and 21' and the lower work and backup rolls 6 and 23 must be extracted out of the rolling mill as a unit in a direction of arrow AR3 into positions shown by two-dot chain lines 6' and 23' in spite of the fact that, as mentioned above, required changing frequencies of the work and backup roll pairs are different from each other. In other words, upon changing of the work rolls with higher changing frequency in the device shown in Fig. 2, unnecessarily the backup rolls must be also extracted out of the rolling mill, which fact is disadvantageous.

**[0013]** The present invention was made in view of the above and has its object to attain changing of work and backup rolls independently from each other and in accordance with their changing frequencies in a rolling mill with upper and lower drive motors arranged oppositely to each other with respect to the paired upper and lower work rolls.

#### BRIEF SUMMARY OF THE INVENTION

**[0014]** According to the present invention, there is provided a roll changing device in a rolling mill comprising a pair of upper and lower work rolls each with an adapter at one end thereof in a pair of housings, said upper and lower work rolls being respectively driven by upper and lower drive motors each via a roll-side universal joint, a spindle and a motor-side universal joint, said upper and lower drive motors being arranged oppositely from each other with respect to the work rolls, said roll changing device comprising first stationary rails in the housing, second stationary rails on a base and coplanar with the first stationary rails, vertically displaceable rails and a changing carriage with vertically extensible jacks and adapted to run on the rails.

**[0015]** This enables the upper work or backup roll to be changed such that the changing carriage is arranged at a lower drive motor side and is inserted from there into the housings, using a space left in the housings by extraction of the lower work roll to an upper drive motor side, and the upper work or backup roll is loaded on the carriage and is extracted to the lower drive motor side. Thus, a roll changing device can be provided even in a rolling mill in which interference between upper work and backup rolls is conventionally inevitable because of insufficient spacing between them. The changing carriage, which tends to interfere with a bearing of a lower spindle and hinder a rolling operation, may be withdrawn

to a height where it does not interfere with the bearing. In the roll changing device, quick changing of the upper work roll may be also carried out.

#### 5 BRIEF DESCRIPTION OF THE DRAWINGS

##### **[0016]**

- Fig. 1 is a side view of a conventional rolling mill;  
 10 Fig. 2 is a side view of a rolling mill disclosed in JP2002-301508A;  
 Figs. 3 and 4 are plan and side views of an embodiment of a roll changing device according to the invention, respectively;  
 15 Fig. 5 is a view looking in the direction of arrows V in Fig. 4 and schematically shows, at its left and right halves, the upper and lower work and backup rolls in different vertical positions or conditions;  
 20 Fig. 6 is a view looking in the direction of arrows VI in Fig. 4;  
 Figs. 7 and 8 are views looking in the direction of arrows VII in Fig. 3 and show changing of the lower work and backup roll units, respectively;  
 25 Fig. 9 is a view looking in the direction of arrows IX in Fig. 4;  
 Fig. 10 is a view looking in the direction of arrows X in Fig. 4;  
 30 Fig. 11 is a view looking in the direction of arrows XI in Fig. 3;  
 Fig. 12 is a view looking in the direction of arrows XII in Fig. 3;  
 Fig. 13 is a side view of a changing carriage according to the invention;  
 35 Fig. 14 is a view looking in the direction of arrows XIV in Fig. 13;  
 Fig. 15 is a view showing interference status between rolls and adapters;  
 40 Fig. 16 is a schematic diagram showing status of roll chocks for upper work and backup rolls;  
 Fig. 17 is a side view showing preparatory status before a roll changing operation;  
 Fig. 18 shows changing of the upper work roll unit sequentially in steps 1-4;  
 45 Fig. 19 shows changing of the upper backup roll unit sequentially in steps 1-3; and  
 Fig. 20 shows changing of the upper work roll unit, using transverse carriages, sequentially in steps 1-4.  
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#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

55 **[0017]** An embodiment of the invention will be described in conjunction with the drawings.

**[0018]** Figs. 3-20 show an embodiment of a roll changing device for a rolling mill according to the inven-

tion. Described first with reference to Figs. 3-11 are component parts of the embodiment which are in common with the related art, its extended art and/or the art already disclosed in JP2002-301508A.

**[0019]** As shown in Figs. 3-5, a rolling mill generally denoted by reference numeral 101 comprises a pair of upper and lower work rolls 131 and 141 supported in a pair of housings 102 via upper and lower roll chocks 132 and 142, respectively. The upper work roll 131 is connected at its one or motor-sides axial end 133, over which an upper adapter 134 is shrinkage-fitted, to an upper drive motor 174 via a roll-side universal joint 171, a spindle 172 and a motor-side universal joint 173, the joint 171 being connected to the adapter 134 on the roll 131 releasably upon roll changing.

**[0020]** Just like the upper work roll 131, the lower work roll 141 is connected at its one or motor-side axial end 143, over which a lower adapter 144 is shrinkage-fitted, is connected to a lower drive motor 184 via a roll-side universal joint 181, a spindle 182 and a motor-side universal joint 183, the joint 181 being connected to the adapter 144 releasably upon roll changing.

**[0021]** The upper and lower drive motors 174 and 184 for the upper and lower work rolls 131 and 141, respectively, are arranged oppositely to each other with respect to the work rolls 131 and 141; that is, the motor-sides of the work rolls 131 and 141 are opposite to each other with respect to the work rolls 131 and 141.

**[0022]** Arranged on the upper work roll 131 is an upper backup roll 151 which is supported through upper roll chocks 152 in the housings 102 to suppress bending deformation of the work roll 151. Arranged above the upper roll chocks 152 are screw down screws 103 which push axially opposite ends of the upper backup roll 151. Each of the screws 103 is driven via drives 111 on tops of the housings 102 by a motor (not shown) to move vertically in mesh with a nut 112 in the top of the housings.

**[0023]** Mounted on the housings 102 is a balance cylinder 106 with a piston 107 pivoted via a pin 108 to a balance beam 109 which has, at its lower opposite edges, hooks 110 engaged with hooks 153 provided by tops of the upper roll chocks 152. As shown in Fig. 6, lower portions of the upper roll chocks 152 are formed with legs 154 each having a cylinder 155 with a piston 156 which pushes up a jaw 135 of the upper roll chock 132 of the upper work roll 131. Reverting to Figs. 3-5, upward actuation of the pistons 107 and 156 causes the upper work roll 131 to be vertically positioned by the screw down screws 103 via the upper backup roll 151 and the upper roll chocks 152; in its lowermost position as shown in left half of Fig. 5, the upper work roll 131 has a lowermost point on a pass line PL of the rolling mill whereas in an uppermost position of the upper work roll 131 as shown in right half of Fig. 5, the suspension beam 109 is in contact with stoppers 114 provided by the housings 102.

**[0024]** Arranged under the lower work roll 141 is a

lower backup roll 161 which is supported through lower roll chocks 162 in the housings 102 to suppress bending deformation of the work roll 141. Arranged under the lower roll chocks 162 are screw up screws 104 which push up axially opposite ends of the lower backup roll 161 via a platform 163. The screw up screws 104 are vertically moved by drives (not shown) beneath the housings 102.

**[0025]** Elevation of the screw up screws 104 causes the lower work roll 141 to be vertically positioned by the screws 104 via the platform 163, the lower roll chocks 162 and the lower backup roll 161; in its uppermost position as shown in left half of Fig. 5, the lower work roll 141 has an uppermost point on the pass line PL. Then, as shown in Fig. 6, wheels 148 each rotatable about a shaft 147 and received in a jaw 145 of the lower roll chock 142 of the lower work roll 141 are suspending in grooves 194 on stationary rails 193 fixed to the housings 102.

**[0026]** Lowering of the screw up screws 104 causes the lower backup roll 161 to be lowered with the lower work roll 141 being thereon, resulting in as shown in right half of Fig. 5 that firstly the wheels 148 of the lower roll chocks 142 are landed on upper surfaces 195 of the stationary rails 193. Then, the platform 163 of the lower backup roll 161 is landed on rails 129 fixed to lower portions of the housings 102 with a gap SP1 being left between the platform 163 and the screw up screws 104.

**[0027]** The shrinkage-fitting of the adapters 134 and 144 over the motor-side ends of the upper and lower work rolls 131 and 141 is in such a degree that the rolling torque can be transmitted only by frictional force therebetween; an outer diameter  $d_4$  of the adapters 134 and 144 is of a size required for obtaining such frictional force. Torque transmission between motor-side axial ends 136 and 146 of the adapters 134 and 144 and upper and lower roll-side universal joints 171 and 181, respectively, is effected through convex contour of the former and complementarily concave formations 115 on the latter as shown in Figs. 9 and 10 with oval or oppositely cutout circular sections having diameter  $d_1$  and width  $B$ ; they are fitted together releasably upon roll changing.

**[0028]** The upper spindle 172 is supported via a bearing 176 by a support beam 175 and is vertically swingable by a cylinder 178, which is pivoted to a bracket 117 projected from the housings 102, about a pin 177 (Fig. 3) which is fixed to a platform 116 on a base and is coaxial with pivot point P1 of the motor-side universal joint 173.

**[0029]** The lower spindle 182 is supported via a bearing 186 by a support beam 185 and is vertically swingable by a cylinder 188, which is pivoted to a platform 119 on the base, about a pin 187 (Fig. 3) which is fixed to a platform 118 and is coaxial with pivot point P2 of the motor-side universal joint 183. The support beam 185 has a roll-side lower end 189 which abuts on a stopper 120 on the platform 119 to thereby define a lowermost swing

limit of the support beam 185 when the support beam 185 is swung down.

**[0030]** Pivoted to a roll-side lower portion of the support beam 185 are a coupling support 121 and a cylinder 122 which are in linkage relationship. During a rolling operation, the cylinder 122 is in its shortest length so that a head 105 of the coupling support 121 is away from the lower roll-side universal joint 181; when the cylinder 122 is expanded to its maximum length upon roll changing, the head 105 is swung and raised about the pin 123 into a position shown by two-dot chain line 105' in Fig. 10 where it abuts and supports the weight of the roll-side universal joint 181.

**[0031]** Arranged below the lower spindle 182 is a cylinder 124. Arranged below the upper spindle 172 is a platform 125 fixed to the base and carrying a transverse frame 126 mounted thereon. As shown in Fig. 7, two transverse rail units 127 are detachably fixed to the transverse frame 126 and may be displaced through push or pull of the frame 126 by the cylinder 128. Furthermore, arranged on the base are stationary rails 192 on which a tractor 191 usually stands by.

**[0032]** As shown in Fig. 11, the stationary rails 193 are fixed to and bridge over the paired housings 102 and are protruded toward the upper drive motor 174 in a cantilever manner. As shown in Fig. 9, pivoted to each of the rails 193 are a coupling support 196 and a cylinder 198 which are in linkage relationship. During a rolling operation, the cylinders 198 are in their shortest length so that the coupling supports 196 are in their open positions; when the cylinders 198 are expanded to their maximum length as shown by two-dot chain line 198', the supports 196 are swung about the pins 197 into closing positions as shown by two-dot chain lines 196' to support the weight of the upper roll-side universal joint 171.

**[0033]** The component parts of the rolling mill 101 mentioned above are in common with the related art, its extended art and/or the art already disclosed in JP2002-301508A. Next, characteristic components of the invention will be described.

**[0034]** As shown in Figs. 11-14, arranged at the lower drive motor side of the stationary rails 193 fixed to the housing 102 are stationary rails 199 on the base and vertically displaceable rails 200 and four lifters 300. Each of the lifters 300 comprises a lifter platform 301 on the base, a jack 302 on the platform 301, and a rail platform 304 vertically displaceable by the jack 302 along guides 303 which in turn extend vertically from the lifter platform 301. The four jacks 302 are concurrently vertically driven by a motor (not shown). A changing carriage 400 rides on the vertically displaceable rails 200 fixed to the rail platforms 304 and the rails 200 and carriage 400 are vertically displaced by the jacks 302. When the vertically displaceable rails 200 are at their lowermost positions, upper surfaces of the rails 200 and of the stationary rails 199 on the base are coplanar with upper surfaces 195 of the stationary rails 193 of the housings

102; the changing carriage 400 is moved on such coplanar surfaces. In Fig. 11, reference numeral L127 denotes length of the transverse rail units 127; L192, length of the stationary rails 192 on the base; L193, length of the stationary rails 193 of the housings; L199, length of the stationary rails 199 on the base; L200, length of the vertically displaceable rails 200; and Lall, a whole rail length.

**[0035]** The changing carriage 400 comprises a body 401, wheels 402 on a bottom of the body 401, and pinions 405 each driven via a reducer 404 by a motor 403. The pinions 405 are adapted to mesh with vertical racks 201 on inner surfaces of the rails 199 and 200 so that actuation of the motors 403 causes the changing carriage 400 to be moved on the rails. Arranged on the body 401 are jacks 407 driven by a motor 406, heads 408 of the jacks 407 being vertically expandable and retractable by the motor 406. Moreover, rails 410 are arranged on the body 401 via platforms 411 and bridge over a jack drive shaft 409.

**[0036]** As shown in Fig. 4, during a rolling operation, the lower spindle 182 is made slant upwardly toward the lower work roll 141; one of bearings 186 for the spindle 182 below the changing carriage 400 and near the rolling mill 101 is at height as shown by two-dot chain line 186' in Fig. 12 and therefore may interfere with the changing carriage 400. To overcome this problem, according to the invention, during a rolling operation the changing carriage 400 is positioned at its stand-by position far away from the rolling mill 101 where the carriage 400 is lifted by the lifters 300.

**[0037]** Lowering of the changing carriage 400 to its position for changing or lowering of the vertically displaceable rails 200 to be coplanar with the upper surfaces 195 of the stationary rails 193 of the housings 102 is effected by swinging down the lower spindle 182 about the pin 187 (Fig. 3) into a position of no interference. In this respect, the position of the stopper 120 is set in advance such that the changing carriage 400 does not interfere with the bearing 182 of the lower spindle 182 when the roll-side lower end 189 of the support beam 185 (Fig. 4) is landed on the stopper 120 on the platform 119.

**[0038]** At the stand-by position of the changing carriage 400, there are provided two transverse carriage units 500. Each of the transverse carriage units 500 comprises a transverse carriage 503 driven by a cylinder 504 pivoted to a platform 501 fixed to the base, and rails 502 fixed to the platform 501 and on which wheels 505 of the transverse carriage 503 moves. The rails 502 are coplanar with the rails 410 on the changing carriage 400 when the carriage 400 is at its stand-by position.

**[0039]** Next, technical background by which the invention became necessary will be described.

**[0040]** Roll changing operation is carried out with the respective rolls being assembled together with their accessories into units: that is,

- (1) an upper work roll unit 130 which is an assembly of the upper work roll 131, the upper roll chocks 132 and the adapter 134,
- (2) a lower work roll unit 140 which is an assembly of the lower work roll 141, the lower roll chocks 142, the adapter 144 and the wheels 148,
- (3) an upper backup roll unit 150 which is an assembly of the upper backup roll 151, the upper roll chocks 152 and the cylinders 155 and
- (4) a lower backup roll unit 160 which is an assembly of the lower backup roll 161, the lower roll chocks 162 and the platform 163.

**[0041]** In Fig. 15, suppose that the diameter of the work rolls 131 and 141 is  $d$  and the outer diameter of the adapters 134 and 144 is  $d_4$ ; then, in order to independently extract the work roll units 130 and 140 in directions of arrows AR2 and AR3 from the rolling mill with the backup roll units 150 and 160 being left in the positions shown in the figure and since  $d_4 > d$ , the respective rolls must be separated apart beyond the interference amounts between the rolls and the adaptors shown by A1, A2 and A3 wherein

$$A1 = d_4 - d \text{ and}$$

$$A2 = A3 = (d_4 - d)/2$$

**[0042]** The interference amounts A1 and A2 may be averted or overcome by separating the respective rolls using the technique of the prior art; however, the interference amount A3 cannot. A reason therefor will be described with reference to Fig. 6.

**[0043]** The rolls worn and surface-roughened during a rolling operation will be changed by new ones in a roll changing operation when an extent of roll surface roughness is beyond a predetermined limit. The old rolls extracted from a rolling mill by such roll changing operation are surface-ground for reuse in the rolling mill. Thus, the diameters of the respective rolls which are maximum at first will be gradually lessened and the rolls are disposed of when their diameters are decreased less than allowable limits in a rolling mill. In Fig. 6, maximum and minimum values of work roll diameter are represented by  $d_{max}$  and  $d_{min}$  and those of the backup roll diameter, by  $D_{max}$  and  $D_{min}$ , respectively.

**[0044]** A whole stroke of the piston 156 is a sum of stroke portions ST1 and ST2 shown in Fig. 6. The stroke portion ST1 is a magnitude absorbing half of differences between maximum and minimum diameters of the upper backup and work rolls 151 and 131, i.e.,  $(D_{max} - D_{min})/2 + (d_{max} - d_{min})/2$ ; situations with maximum and minimum diameters are respectively shown in left and right of Fig. 6 in the form of bare essentials of stroke amounts. The stroke portion ST2 is a magnitude absorb-

ing the interference amount A4, i.e., distance between the upper end of the roll chock 132 of the upper work roll 131 and the lowermost point of the upper backup roll 151 when the roll 151 is at its maximum diameter; this is also shown in the form of bare essentials of stroke amount.

**[0045]** However, a gap between the upper backup roll leg 154 and the lower work roll chock 142 is C1 when the rolls are at maximum diameter whereas it becomes narrowed into C2 when the rolls are at minimum diameter, which enables no further increase of the stroke of the piston 155. If it were increased further, then C2 would become zero or theoretically less than zero, resulting in a substantial gap between the upper and lower work rolls 131 and 141 and failure to providing a rolling mill. On the other hand, distance between the upper work and backup rolls cannot be sufficiently increased to avert or overcome the interference amount A3 since the interference amount A3 is greater than the interference amount A4.

**[0046]** In order to solve the above-mentioned technical contradiction and make it possible to replace the respective rolls even in a rolling mill with upper work and backup rolls 131 and 151 which cannot have required distance between them enough for roll changing, the present invention adopts the changing carriage 400.

**[0047]** Next, mode of operation of the embodiment according to the invention will be described.

**[0048]** According to the invention, after a rolling operation and before a roll changing operation, the rolling mill 101 is made into changing preparation status as shown in Fig. 17:

(1) the screw up screws 104 are lowered so that the wheels 148 of the work roll chock 142 are landed on the upper surfaces 195 of the stationary rails 193 of the housings 102 to thereby form a gap SP2 between the lower work and backup rolls 141 and 161, and the platform 163 is landed on the rails 129 to thereby form a gap SP1 between the platform 163 and the screw up screws 104;

(2) the screw down screws 103 are elevated to abut the shoulders 113 (Fig. 5) of the suspension beam 109 onto the stoppers 114 of the housings 102, thereby elevating the upper work and backup rolls 131 and 151 to their uppermost positions, with the upper work and backup rolls 131 and 151 being kept in contact with each other;

(3) the head 105 of the coupling support 121 pivoted to the lower support beam 185 is swung about the pin 123 by the cylinder 122 into position shown by two-dot chain line 105' in Fig. 10 of abutment with the lower roll-side universal joint 181 to support the weight of the latter, a hydraulic circuit for the cylinder 122 being closed to seal off hydraulic pressure in the cylinder; and

(4) the coupling supports 196 pivoted to the stationary rails 193 of the housings are swung about the

pins 197 by the cylinders 198 as shown in Fig. 9 into closing positions shown by two-dot chain lines 196', the upper roll-side universal joint 171 being not on the closed coupling supports 196' at this time yet.

**[0049]** The roll changing operation is carried out in such a manner that firstly the lower work roll unit 140 is extracted from the rolling mill 101 to provide a space for insertion or accommodation of the changing carriage 400. In Fig. 17, a tractor 191 is moved from the stationary rails 192 and run on the transverse rail unit 127 and on the stationary rail 193 of the housings 102 toward the lower work roll unit 140 to thereby engage the hook 202 on the tractor 191 with a hook 149 of the lower roll chock 142 and extract the lower work roll unit 140 from the rolling mill 101 to a position on one of the transverse rail units 127 shown by two-dot chain line 140'. As shown in Fig. 7, a new lower work roll unit 140" is provided in advance on the other of the transverse rail units 127 and the transverse frame 126 is driven by the cylinder 128 in a direction of arrow AR4 for changing of the lower work roll unit. Insertion of the new lower work roll unit 140" into the rolling mill 101 is carried out in a manner reverse to the above.

**[0050]** Changing of the lower backup roll unit 160 is carried out such that in Fig. 17, a hook 203 on a tip of the cylinder 124 is engaged with a hook 164 on the platform 163 and the lower backup roll unit 160 is extracted from the rolling mill by the cylinder 124 to a position on the transverse frame 126 shown by two-dot chain line 160'. In this case, as shown in Fig. 8, one of the two transverse rail units 127 is removed out in advance. The lower backup roll unit 160' extracted onto the transverse frame 126 is just below the upper spindle 172 so that a direct crane operation cannot be effected to the lower backup roll unit 160'; therefore, it is traversed by the cylinder 128 in a direction of arrow AR5 into a position allowing such crane operation, and the lower backup roll unit 160' is changed with a new lower backup roll unit, using a crane. The new lower backup roll unit can be inserted into the rolling mill in a manner reverse to the above. By removing both the transverse rail units 127 and preparing a new lower backup roll unit on the transverse frame 126 in advance, quick changing of the lower backup roll unit may be also carried out.

**[0051]** Changing of the upper work roll unit 130 is carried out in steps shown by Fig. 18 in absence of the lower work roll unit 140 in the rolling mill:

[step 1] The lower spindle 182 is swung down about the pin 187 (Fig. 3) by the cylinder 188 pivoted to the platform 119 until the tip 189 of the support beam 185 (Fig. 17) abuts on the stopper 120 of the platform 119. Then, the changing carriage 400 is lowered from its stand-by position to a changing position, using the lifters 300.

[step2] With the jack heads 408 (Fig. 13) being at their uppermost positions, the changing carriage

400 is inserted into the rolling mill. Then, the pistons 156 of the cylinders 155 (Fig. 6) in the upper backup roll chocks are lowered to land the upper work roll unit 130 on the jack heads. Here, the interfere amount A4

between the lower end of the upper backup roll and the upper end of the upper work roll chock as shown in Fig. 6 is averted or overcome to separate the jaw 135 (Fig. 6) and the pistons 156 apart. Also, the upper work roll 131 and the upper backup roll 151 are also apart from each other. Concurrently the upper spindle 172 is swung down about the pin 177 (Fig. 3) so that the roll-side universal joint 171 is landed on the closed coupling supports 196' (Fig. 9).

[step 3] The changing carriage 400 with the upper work roll unit 130 mounted thereon is moved by an amount T1 in a direction away from the rolling mill. Then, as shown in Fig. 16, the upper work roll chocks 132 are away from the upper backup roll chocks 152 in a direction of roll axis, and as shown in step 3 of Fig. 18, the motor-side end 136 of the adapter is disengaged from the roll-side universal joint 171. In Fig. 16, B132 denotes width of the chocks 132; B152, width of the chocks 152; and BD, separation of the chocks 132 and 152 away from each other.

[step 4] The heads 408 of the jacks (Fig. 13) are lowered to their lowermost positions to avert the interference amount A3 between the adapter 134 and the upper backup roll 151 (Figs. 6 and 15) so that the upper work roll unit is extracted from the rolling mill to a position shown by two-dot chain line 130'. The extracted upper work roll unit 130' is changed by a new upper work roll unit in a manner disclosed below with reference to Fig. 20. Insertion of the new upper work roll unit into the rolling mill is effected in a manner reverse to the above.

**[0052]** Changing of the upper backup roll unit 150 is carried out in steps 1-3 shown in Fig. 19 in absence of the upper and lower work roll units 130 and 140 in the rolling mill:

[step 1] the changing carriage 400 is inserted into the rolling mill;

[step 2] the screw down screws 103 are lowered to lower the upper backup roll unit 150 such that the legs 154 of the upper roll chock are about to be landed on the body 401 of the changing carriage; and then

[step 3] the balance beam 109 connected to the pin 108 of the piston 107 of the balance cylinder 106 (Fig. 4) is lowered to land the legs 154 on the body 401 of the changing carriage. Then, the screw down screws 103 and the upper roll chocks 152 are relatively moved apart from each other and the hooks 110 of the balance beam 109 are disengaged from the hooks 153 (Fig. 5) of the upper roll chocks.

Then, the upper backup roll is extracted or drawn out into a position shown by two-dot chain line 150' and changed with a new backup roll unit, using a crane. The new upper backup roll unit may be inserted into the rolling mill in a manner reverse to the above.

**[0053]** The upper work roll unit 130 may be quickly changed in steps shown by Fig. 20 using the transverse carriage units 500:

[Step 1] A new work roll unit 130" is prepared in advance on one of the two transverse carriages 503, and the old upper work roll unit 130' on the changing carriage 400 and extracted from the rolling mill 101 is positioned between the transverse carriages 503. At this time, the rails 410 on the changing carriage 400 (Fig. 13) are coplanar with the rails 502 on the platform 501.

[Step 2] The old upper work roll unit 130' is lifted to its uppermost position by heads 408 of the jacks. The empty transverse carriage 503 is moved on the rails 410 by the cylinder 504 and the heads 408 of the jacks are lowered to land the old upper work roll unit 130' on the transverse carriage 503.

[Step 3] The new and old upper work roll units 130' and 130" are traversed in a direction of arrow AR6 by the cylinder 504.

[Step 4] After the new upper work roll unit 130" is inserted into the rolling mill, the changing carriage 400 is lifted by the lifters 300 to provide a space for the bearing 186 of the lower spindle 182 to be swingingly lifted to a height shown by two-dot chain line 186.

**[0054]** As disclosed above, arranged as extensions for the stationary rails fixed to the housing are the base stationary rails and the vertically displaceable rails on which the changing carriage 400 with the jacks is provided for traverse, thereby providing a roll changing device which enables roll changing even if spacing between the upper work and backup rolls 131 and 151 is insufficient. This makes it possible to construct a rolling mill capable of transmitting a rolling torque of a magnitude enough for rolling of new material which requires great draft or strain rolling at lower temperature. Moreover, quick changing of an upper work roll unit may be made, which fact is drastically advantageous from financial viewpoint.

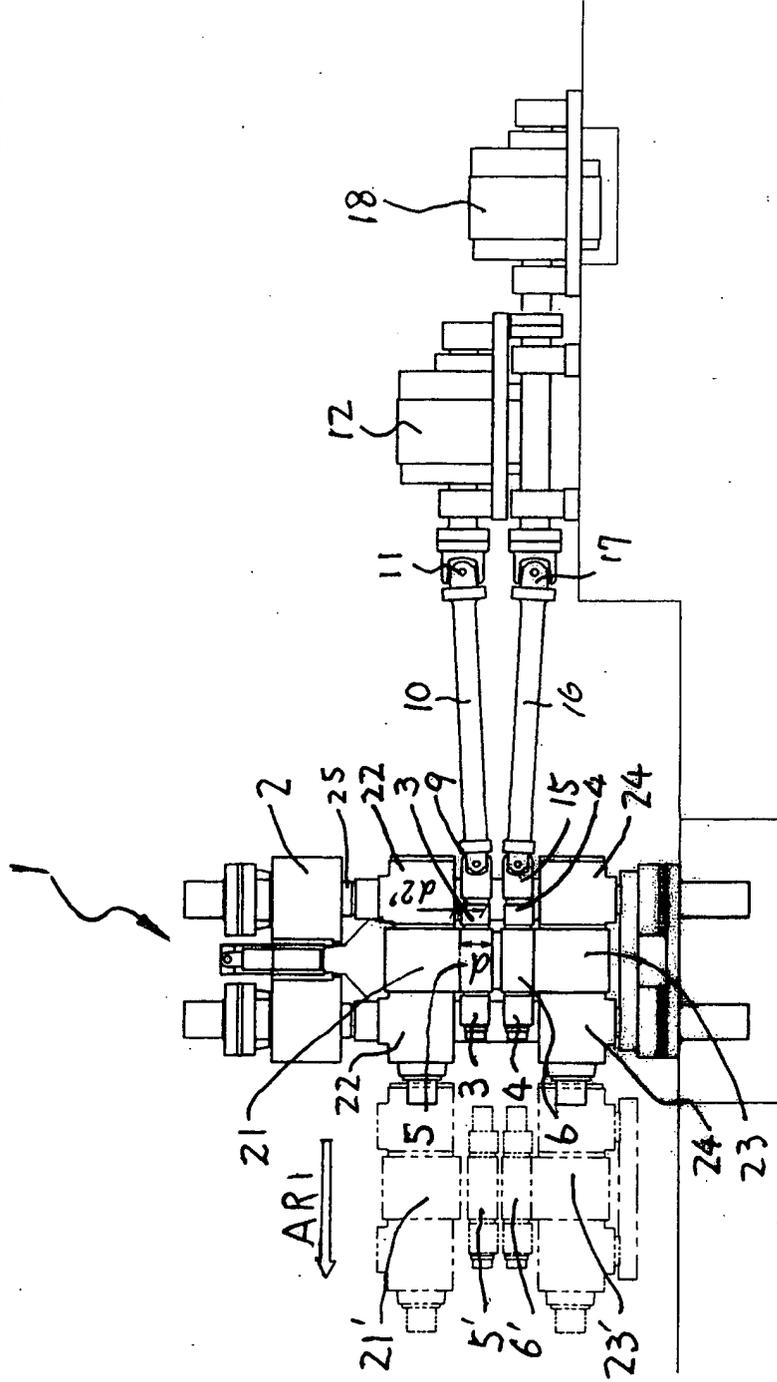
**[0055]** It is to be understood that the roll changing device according to the invention is not limited to the above-mentioned embodiment and that various changes and modifications may be made without departing from the scope and spirit of the invention. For example, universal joint may be in the form of slippers.

## Claims

1. A roll changing device for a rolling mill comprising a pair of upper and lower work rolls (131 and 141) each with a motor-side end over which an adapter (134, 144) is fitted, said upper and lower work rolls (131 and 141) being driven by the upper and lower drive motors (174 and 184) through the roll-side universal joints (171 and 181), spindles (172 and 182) and motor-side universal joints (173 and 183), respectively, said upper and lower drive motors (174 and 184) being arranged oppositely with respect to said work rolls (131 and 141), said roll changing device comprising a changing carriage (400) which is inserted, upon roll changing operation of the upper work roll (131), from a lower drive motor side into a space in the rolling mill (101) provided by the lower work roll (141) extracted from the rolling mill (101) toward an upper drive motor side, the upper work roll (131) being loaded on said changing carriage (400) and then extracted together therewith from the rolling mill (101) to said lower drive motor side.

FIG. 1

RELATED ART



RELATED ART

FIG. 2

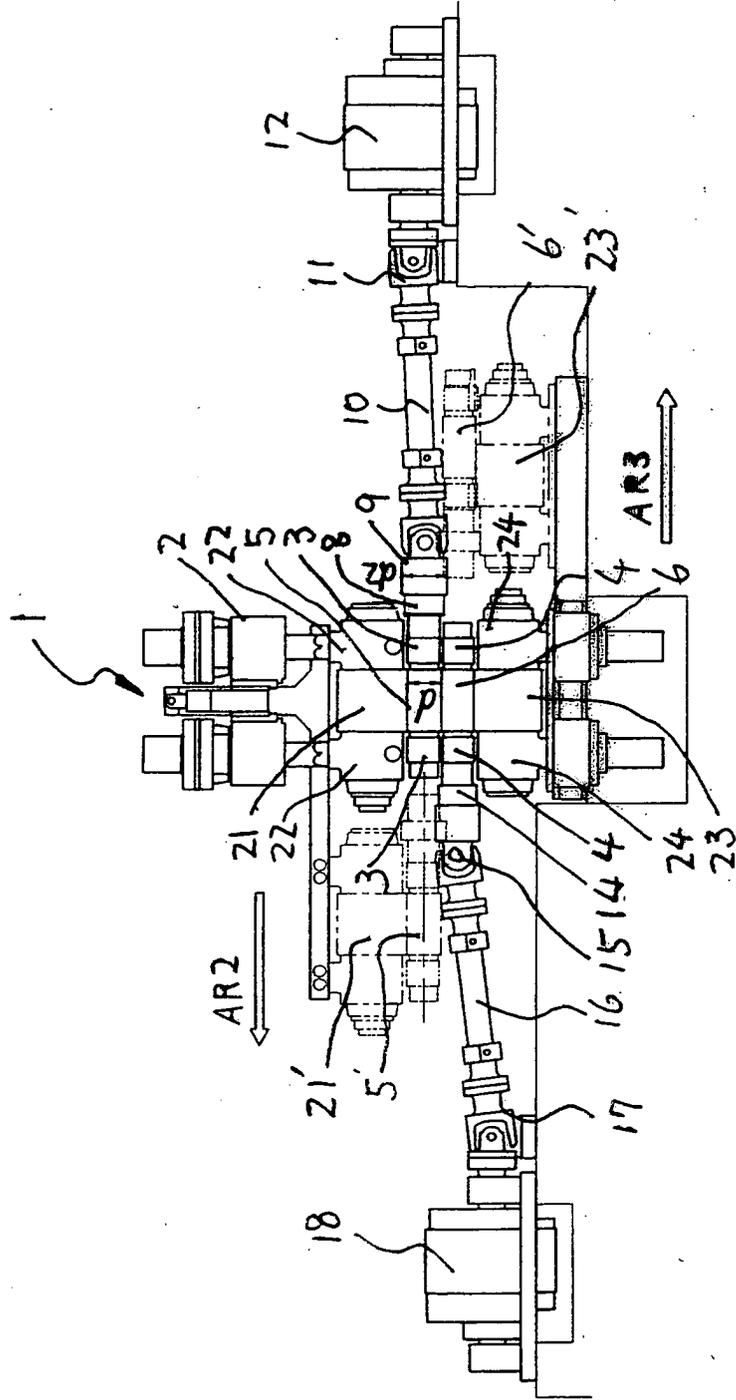


FIG. 3

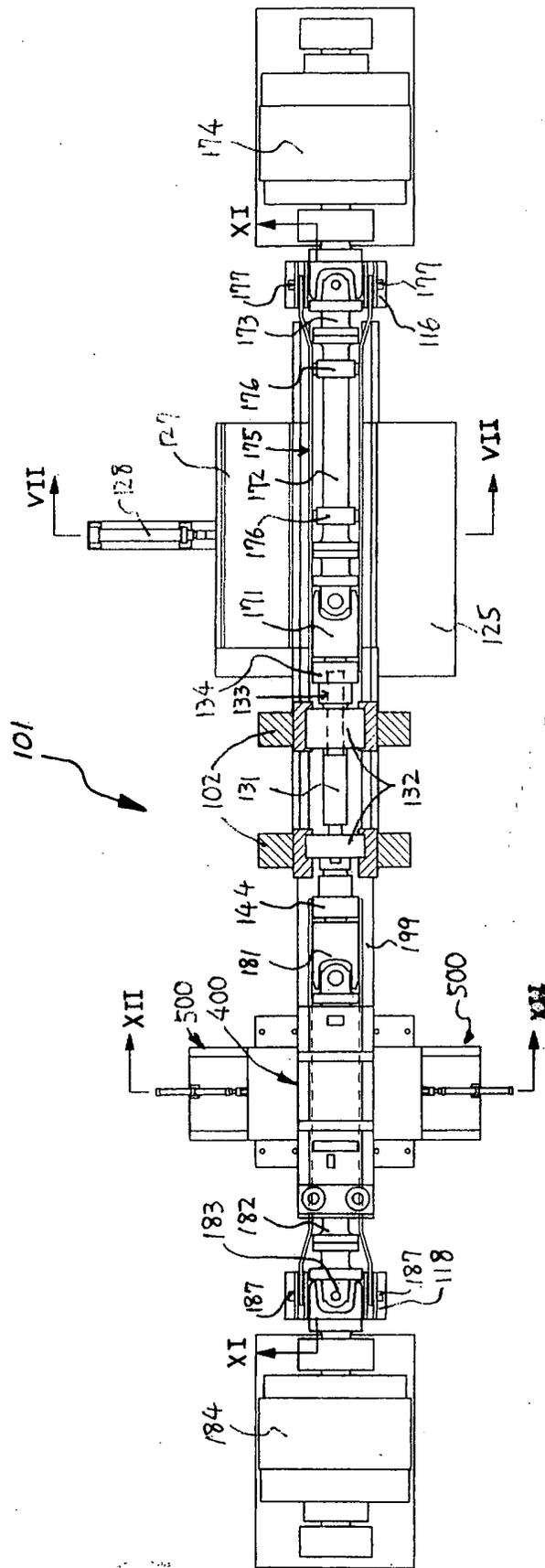


FIG. 4

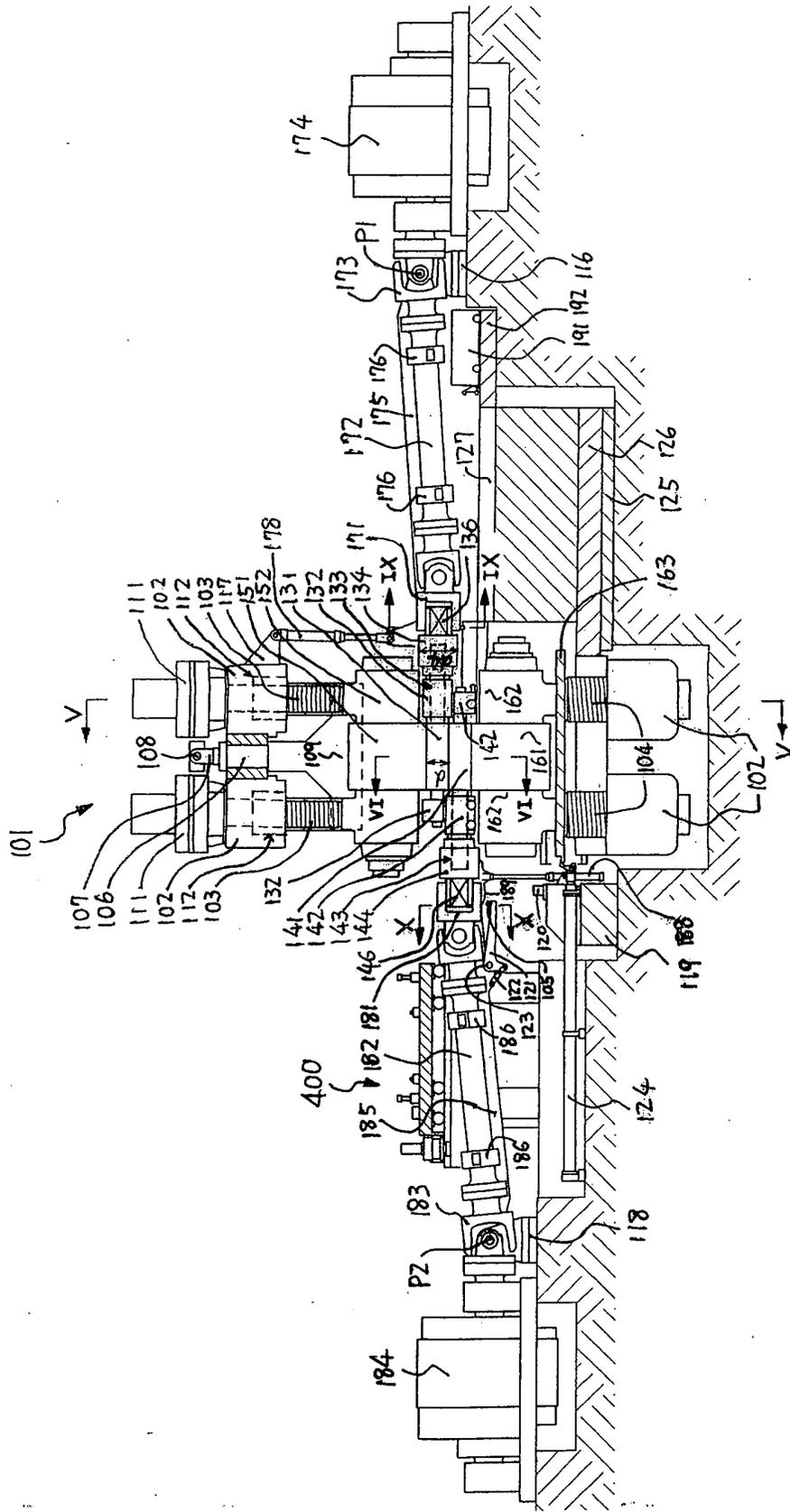


FIG. 5

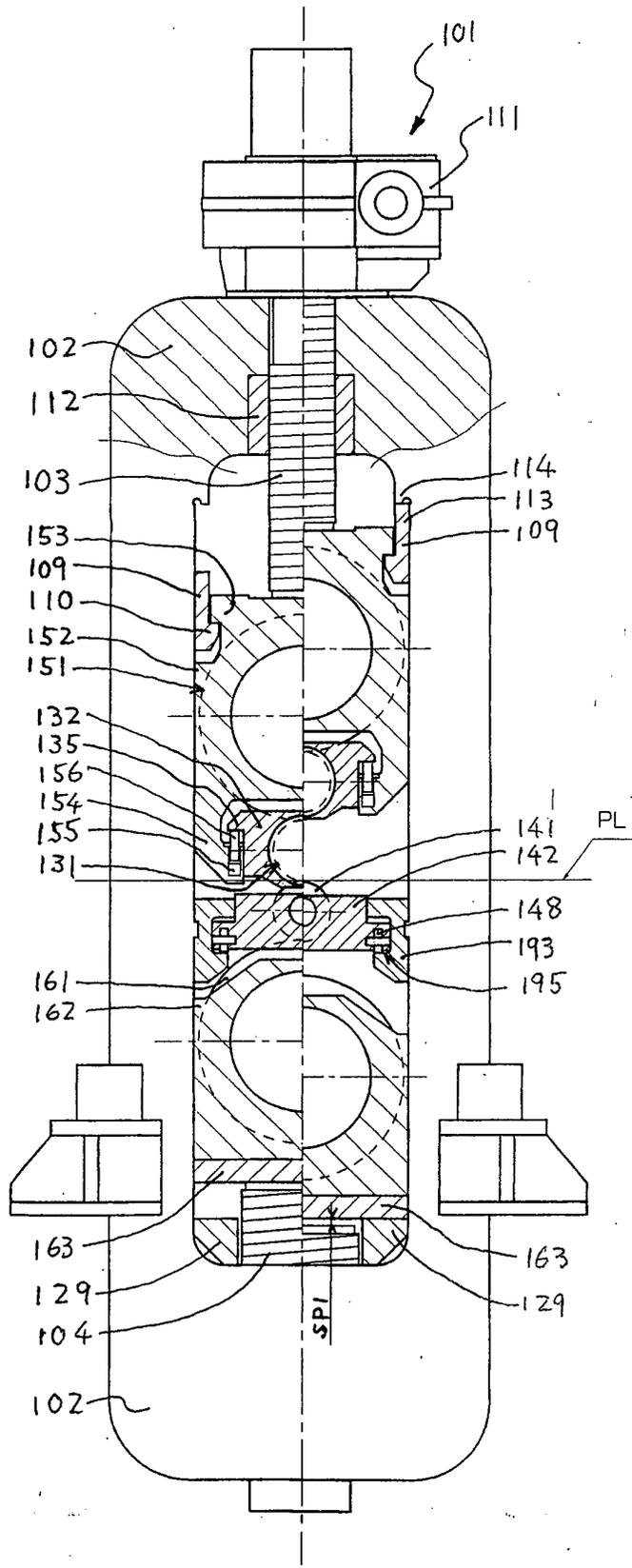


FIG. 6

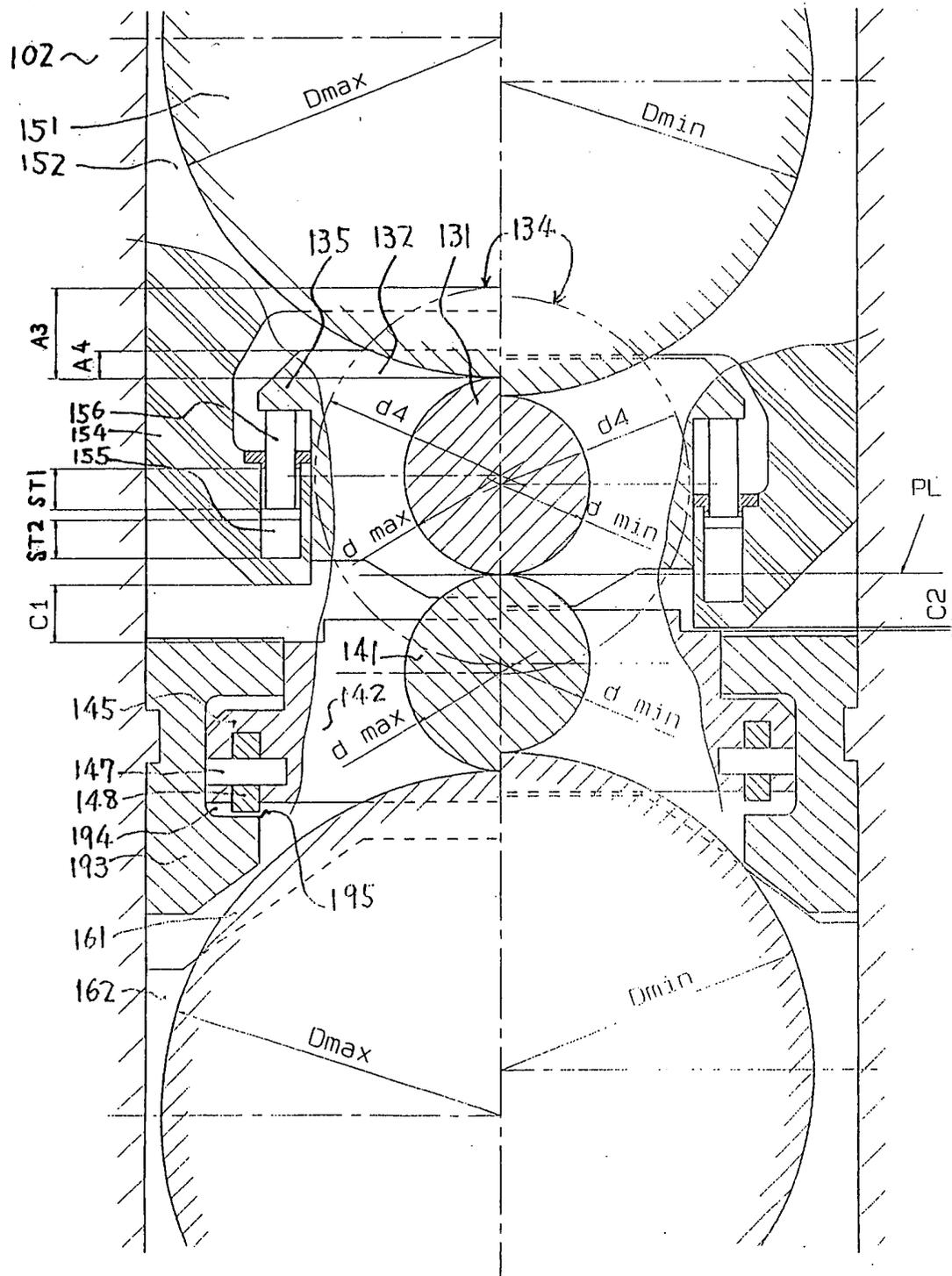


FIG. 7

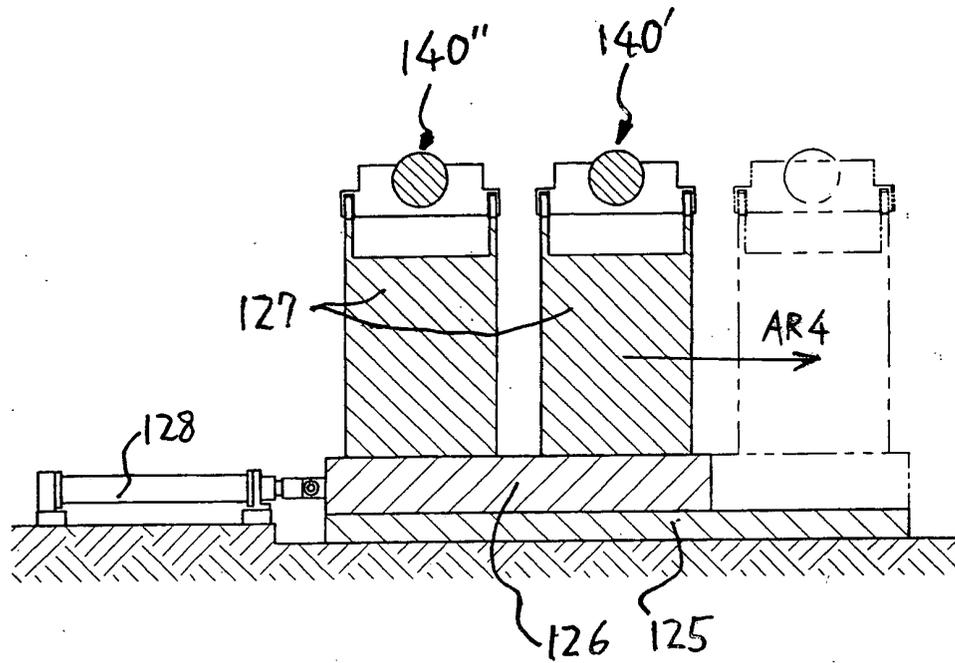


FIG. 8

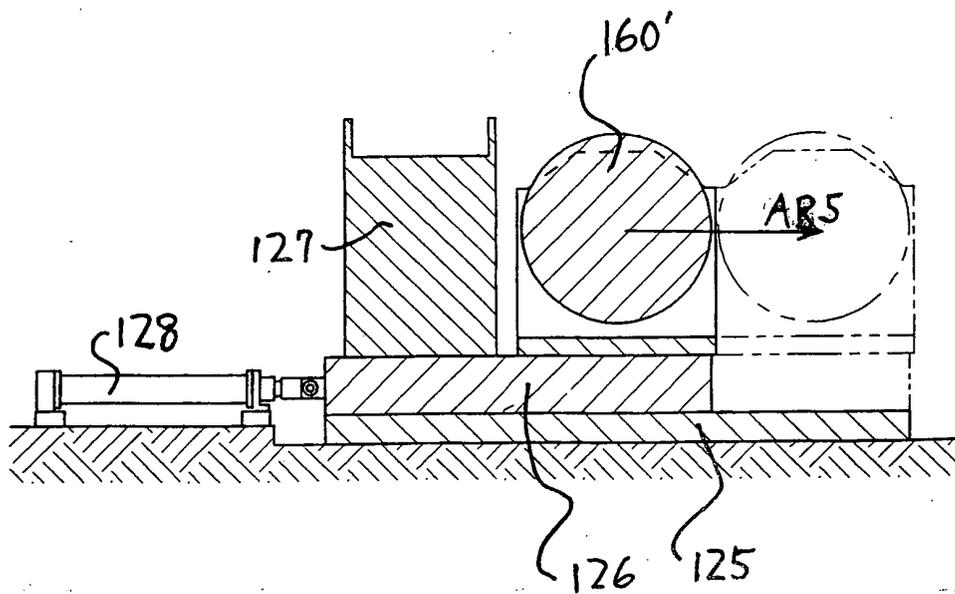


FIG. 9

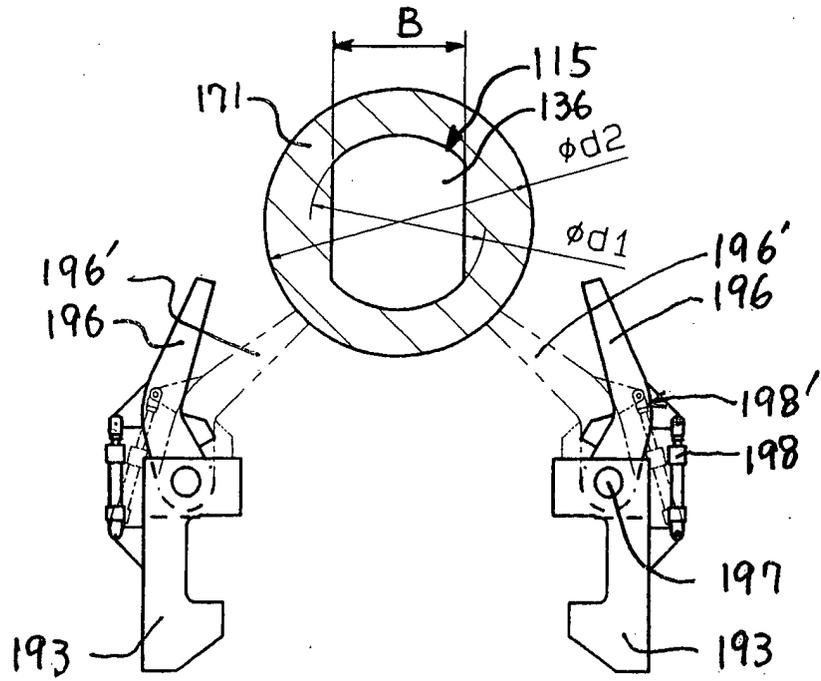


FIG. 10

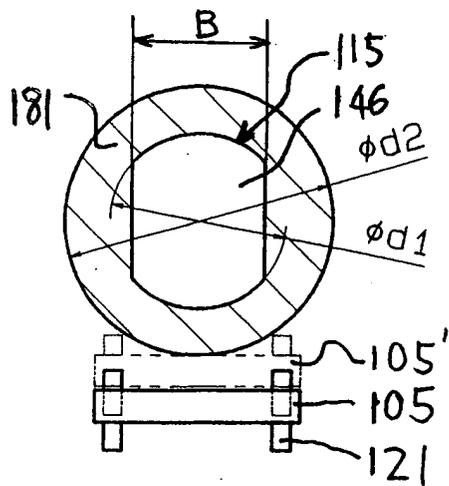


FIG. 11

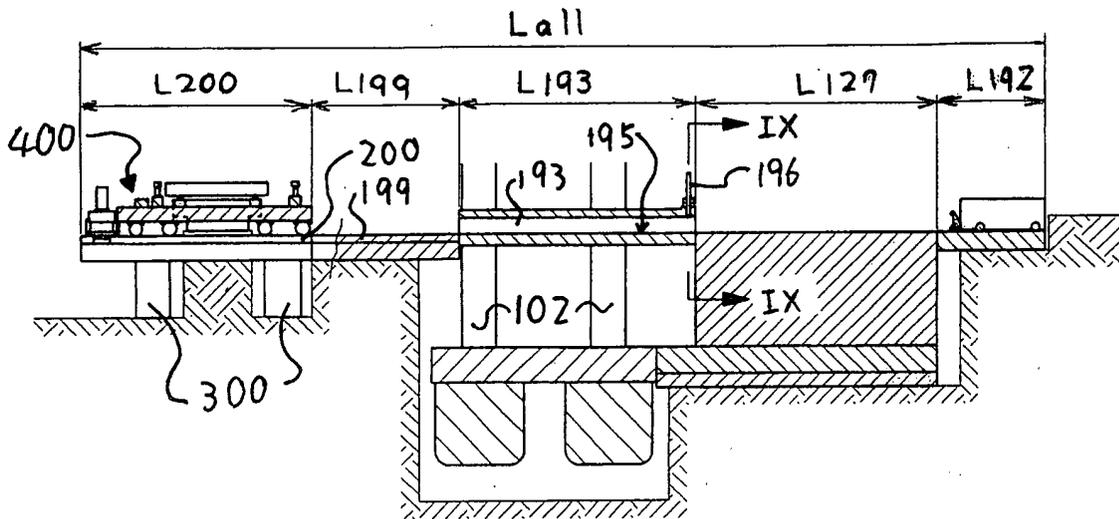


FIG. 12

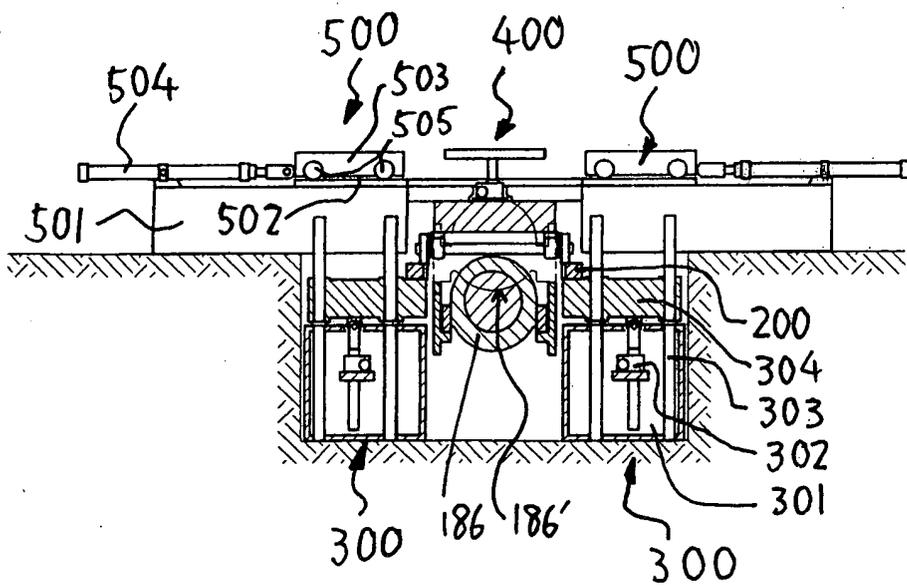




FIG. 15

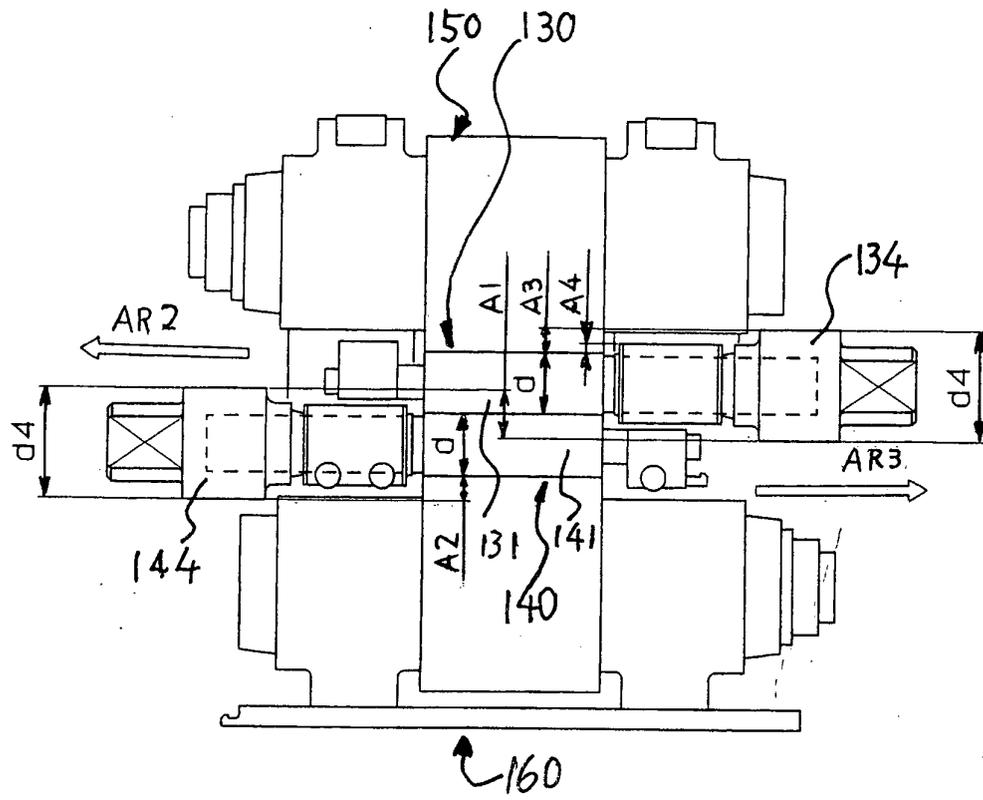


FIG. 16

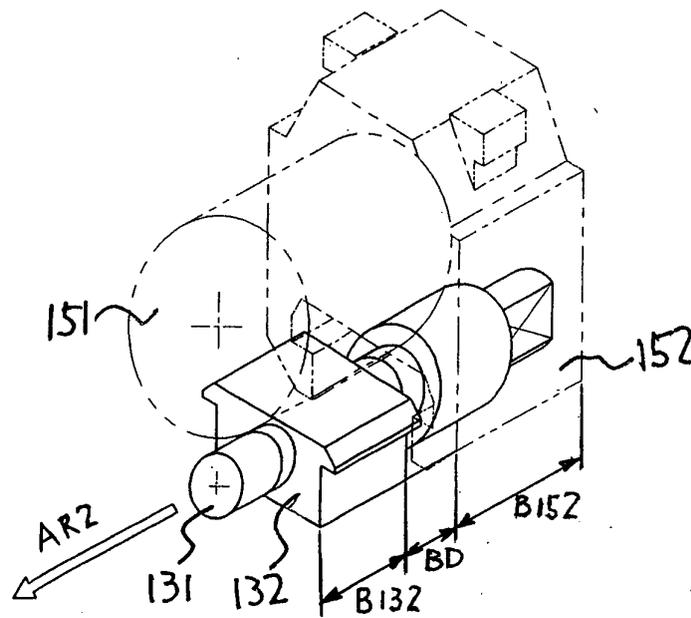




FIG. 18

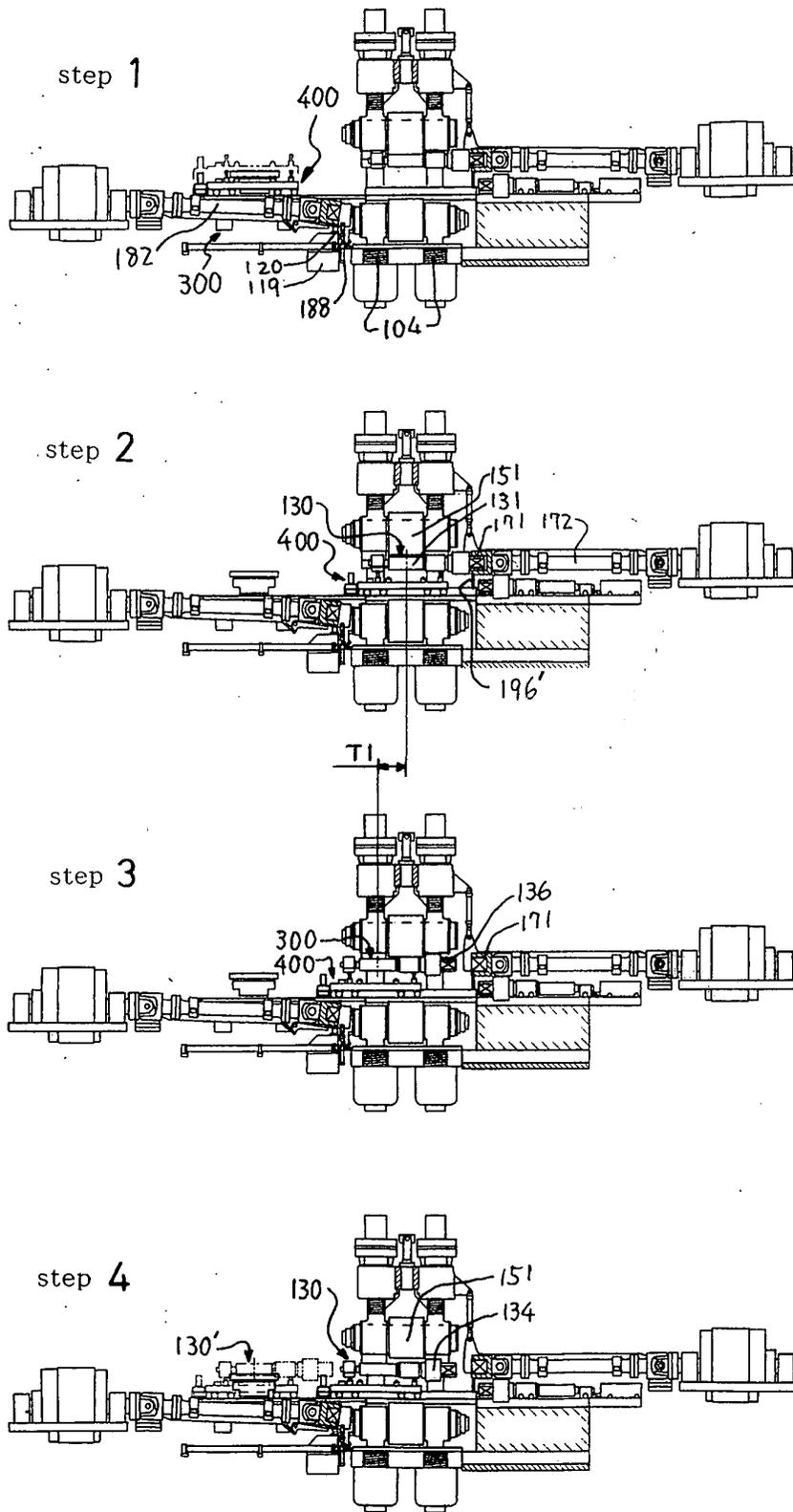


FIG. 19

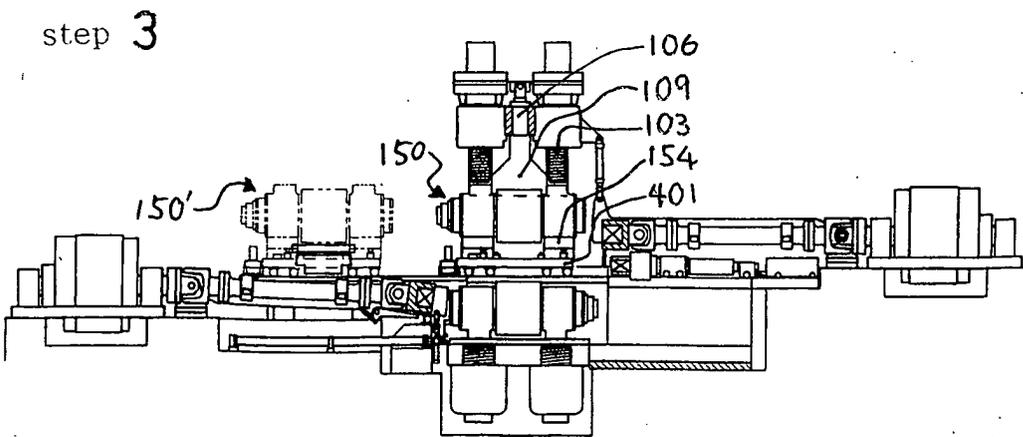
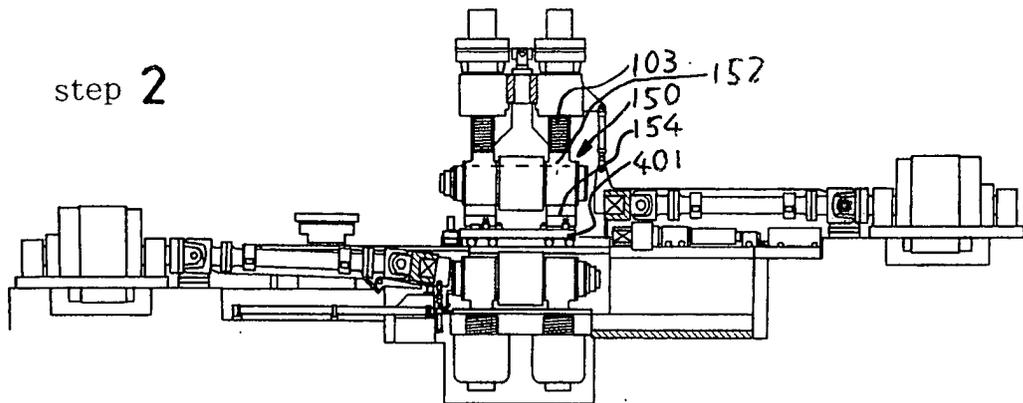
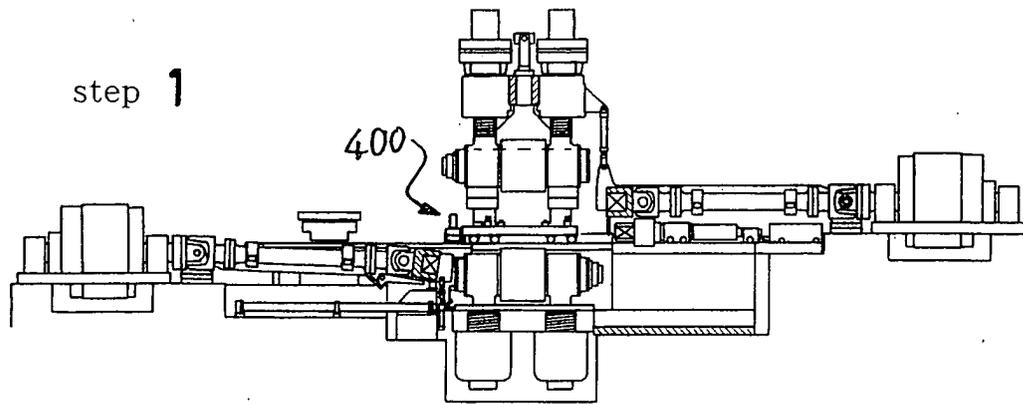
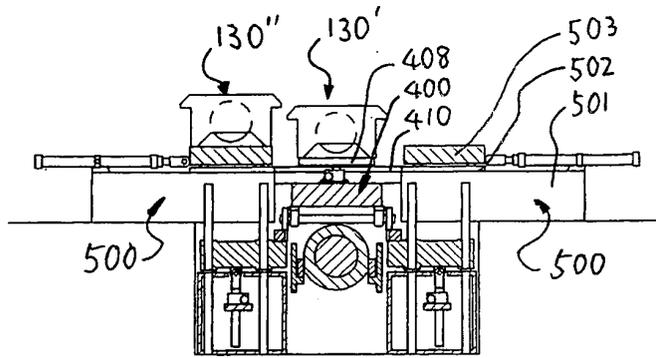
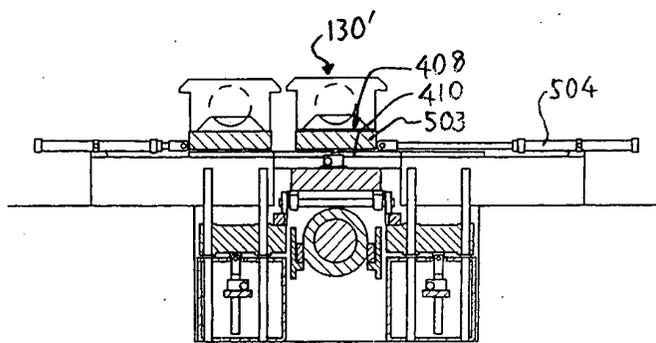


FIG. 20

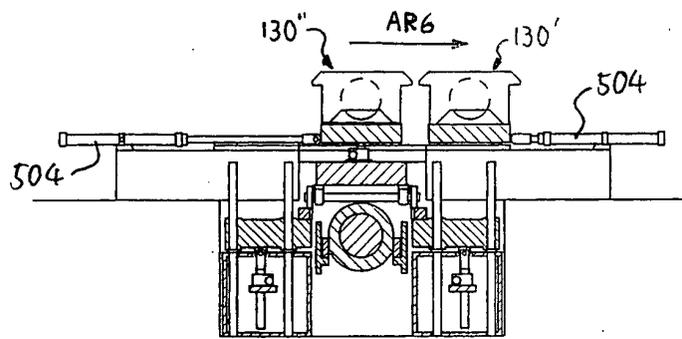
step 1



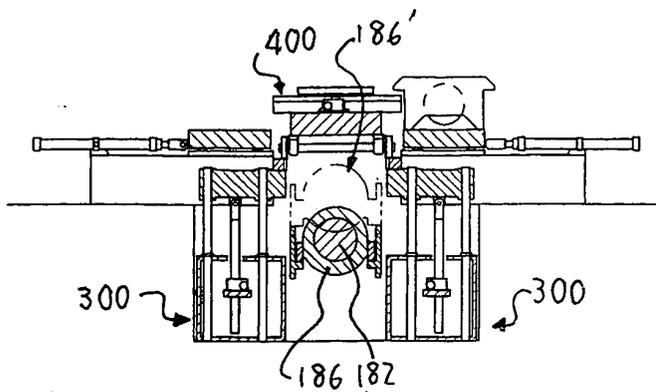
step 2



step 3



step 4





European Patent  
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EUROPEAN SEARCH REPORT

Application Number  
EP 03 00 5566

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
P,A, D	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 02, 5 February 2003 (2003-02-05) & JP 2002 301508 A (ONO SEKKEI JIMUSHO:KK), 15 October 2002 (2002-10-15) * abstract *	1	B21B31/10
A	--- PATENT ABSTRACTS OF JAPAN vol. 012, no. 384 (M-753), 13 October 1988 (1988-10-13) & JP 63 137507 A (ISHIKAWAJIMA HARIMA HEAVY IND CO LTD), 9 June 1988 (1988-06-09) * abstract *	1	
A	--- PATENT ABSTRACTS OF JAPAN vol. 007, no. 254 (M-255), 11 November 1983 (1983-11-11) & JP 58 138507 A (HITACHI SEISAKUSHO KK), 17 August 1983 (1983-08-17) * abstract *	1	
A	--- GB 1 144 410 A (BLAW KNOX CO) 5 March 1969 (1969-03-05) * figure 1 *	1	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.7) B21B
Place of search MUNICH		Date of completion of the search 24 April 2003	Examiner Forciniti, M
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 03 00 5566

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

24-04-2003

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2002301508 A	15-10-2002	EP 1247592 A2	09-10-2002
JP 63137507 8 A		NONE	
JP 58138507 8 A		NONE	
GB 1144410 A	05-03-1969	DE 1602028 A1	04-06-1970
		FR 1527193 A	31-05-1968
		US 3323345 A	06-06-1967

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82